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Low-carbon Mutual Funds

Finance Working Paper N° 659/2020
April 2020

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Abstract

We show that mutual funds compete for climate-conscious investment flows. In April 2018, Morningstar introduced a climate-focused label for mutual funds. The release of the “Low Carbon Designation” induced reactions on both the demand and supply sides of the market. First, investors flocked to funds receiving this eco-label. Second, active funds that missed the label at its initial release responded to the new incentive by shifting their holdings towards more climate-friendly firms. In sum, climate-related information can trigger competition by financial intermediaries along their climate performance. However, the resulting portfolio shifts may also expose investors to higher idiosyncratic risks.

Keywords: Behavioral finance, climate change, eco-labels, investor preferences, mutual funds, sustainable finance

JEL Classifications: D03, G02, G12, G23

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1 Introduction

Climate change is one of the key economic challenges of our time. Economists and public policy scholars increasingly agree on the merits of carbon taxes and/or tradable permits to ensure adequate pricing of carbon emissions at the international level.[1] However, given the current practical and political challenges in implementing such policies, policy-makers are also exploring alternative strategies that can accelerate the transition to a low-carbon economy. One central approach is to make "financial flows consistent with a pathway towards low greenhouse gas emissions" (Paris Agreement, Article 2) by improving the climate-related information available to investors about their portfolios.[2]

The success of this strategy, however, relies on the twin assumptions that investors will respond to more transparency by demanding more climate-conscious products and that fund managers and other intermediaries will in turn shift their assets towards more climate-friendly holdings. In this paper, we investigate whether these assumptions hold. We do so by studying mutual fund and investor behavior.

Mutual funds play a crucial role in the overall economy. As of year-end 2018, US and European mutual funds, respectively, had some USD 17.7 trillion and USD 11 trillion in assets under management (Investment Company Institute, 2019). On April 30, 2018, Morningstar, the most important information provider in the mutual fund industry, introduced an eco-label for mutual funds, the Low Carbon Designation (LCD).[3] This event altered the information

[1] See Nordhaus (2019). On the internalization of external costs in general see the fundamental contributions of Pigou (1920), Coase (1960), and Weitzman (1974).

[2] For instance, as a follow-up to the "Action plan for sustainable finance" of March 2018 (European Commission, 2018), regulators are currently developing the criteria for an EU-wide eco-label for financial products that should help retail investors "express their investment preferences on sustainable activities."

[3] Many studies (e.g., Ben-David et al., 2019, Del Guercio and Tkac, 2008, and Hartzmark and Sussman, 2019) document the strong influence of Morningstar's ratings and classifications on investor behavior.

available to investors on the climate performance of mutual funds.

Using this quasi-experimental setting, we establish three key results: First, funds that are awarded the LCD enjoy substantially higher monthly flows than conventional funds. Second, active mutual funds that missed the label at its initial release shifted their holdings towards more climate-friendly firms. That is, funds began to compete for flows also through their climate performance. Third, funds labeled as low-carbon by Morningstar have higher idiosyncratic volatility than conventional funds, due to their lower sectoral diversification.

To develop these results, we first show in Section 4 that investors reward funds recognized as "climate-friendly". Funds that were labeled as low-carbon at the end of April 2018 on average enjoyed a 24 basis points increase in their monthly net flows relative to conventional (not-low-carbon) funds. This is a sizable economic impact, corresponding to about half of the effect of a one-standard deviation stronger financial performance in the prior month.

These findings hold controlling for many other factors, including the generic fund performance ("Stars") and sustainability ratings ("Globes") of Morningstar for which prior work had shown an impact on fund flows (Del Guercio and Tkac, 2008, Ammann et al., 2018, Hartzmark and Sussman, 2019). A battery of robustness checks alleviate concerns that the findings are driven by other unobserved factors.

Why do investors prefer low-carbon funds? We find a stronger boost of flows for retail (vs. institutional) funds, poor (vs. good) financial performers, and low (vs. high) sustainability funds. Moreover, the effect of LCD on fund flows remains virtually unchanged even when we account for *future* fund performance in the regressions. Together, these findings suggest that non-pecuniary preferences, rather than expectations for higher returns, play a major role in the demand for low-carbon mutual funds.

Next, Section 5 studies how active mutual funds reacted to the revealed investor preferences and to the implicit incentives created by the LCD. While Ammann et al. (2018) and Hartzmark and Sussman (2019) document a flow effect due to Morningstar's Globes ratings, they do not study the supply-side reactions of fund managers. Our setting is uniquely suited to deliver an analysis of fund responses because the LCD is based on absolute criteria (not on a relative ranking, as is the case for the Globes). The ability of a fund manager to reach the LCD, therefore, does not depend on the portfolio choices of her peers.

We find that after the label's introduction and through the third quarter of 2019, active funds that did not receive the label at its first release rebalanced their portfolios towards more climate-conscious firms. For example, during the six quarters the LCD was in place, non-recipients reduced their portfolio Fossil Fuel Involvement (the portfolio's exposure to fossil-fuel-related firms) by 1.75 percentage points relative to LCD-recipients. This effect becomes substantially larger when we account for changes in the underlying relative asset valuations of fossil-fuel intensive sectors.

We interpret the observed behavior of fund managers as a supply-side reaction to the surge in demand for climate-responsible investment products, supported and accelerated in the mutual fund industry by the release of the LCD. To reinforce our analysis, we show that the reaction of fund managers is particularly strong when they have the flexibility needed to adjust their climate performance, and when the incentives of receiving the additional low-carbon accreditation are high. Moreover, funds' efforts pay off: Receiving (losing) the LCD in quarterly updates that followed the initial publication through September 2019 translates into positive (negative) flow effects that are comparable to those at the initial introduction.

However, the competitive response of mutual fund managers, tilting portfolios towards

more climate-responsible investments, may reduce risk diversification. In Section 6, we show that, on average, LCD funds have an idiosyncratic monthly volatility 23 basis points (16% of the median) higher than non-LCD funds, due to the under-weighting of carbon-intensive sectors. Hence, during the transition to a low-carbon economy, investors may face a trade-off between choosing LCD funds and diversification of their portfolios. Importantly, as we discuss in the text, this result emerges because of the specific design of the LCD.

Our paper contributes to the literature, first, by showing how the revealed (climate) preferences of investors can trigger a change in the behavior of profit-seeking entities, in our case mutual funds. Heinkel et al. (2001) theoretically show that if a significant share of shareholders adopts environmentally conscious investment strategies, it will have an impact on a firm's cost of capital. This will, in turn, trigger a change in the environmental practices of the firm, which will start addressing the preferences of its investors. The mutual fund industry is an ideal setting to test this mechanism, not only due to its economic importance: First, fund flows allow us to measure directly the attractiveness to investors/clients of a specific type of firm products, mutual fund portfolios. Second, while changes in corporate behavior may in general take time to materialize, fund managers can react quickly to shifts in the revealed preferences of their clients. These reactions are then observable through changes in mutual fund holdings.

Second, we advance the understanding of the competitive behavior of mutual funds. Important prior studies in this area include Berk and Green (2004), Berk and Van Binsbergen (2015), Chevalier and Ellison (1997), Cooper et al. (2005), Donaldson and Piacentino (2018), Guercio and Reuter (2014), Harris et al. (2015), Hortaçsu and Syverson (2004), Kempf and Ruenzi (2008), and Wahal and Wang (2011). While all these papers study how mutual funds

compete for flows through traditional financial metrics, such as fees and returns, our paper is the first to show that they also compete through climate performance.[4]

Third, we complement the literature on investor behavior, in particular the literature on whether and why investors prefer socially responsible investment products (e.g., Anderson and Robinson, 2019, Barber et al., 2019, Bassen et al., 2018, Bauer et al., 2018, Bonnefon et al., 2019, Renneboog et al., 2011, Riedl and Smeets, 2017).[5] Differently from most previous works, we provide causal evidence of the effects of investor preferences for a specific salient dimension of sustainability, namely, climate responsibility. The natural experiment that we analyze is appealing in this respect. Before the introduction of the LCD, investors already had easy-to-process information about the general sustainability performance of funds (Hartzmark and Sussman, 2019). Hence, the effect that we identify can be attributed to the climate preferences of investors, net of both their preferences for sustainability more broadly defined and of more traditional financial factors.

2 Empirical setting

On April 30, 2018, Morningstar introduced the "Low Carbon Designation" (LCD) for mutual funds. This label is depicted as a green leaf icon which is visible on the fund's report, as shown in Figure 1. While not the first type of sustainability evaluation for funds, the LCD

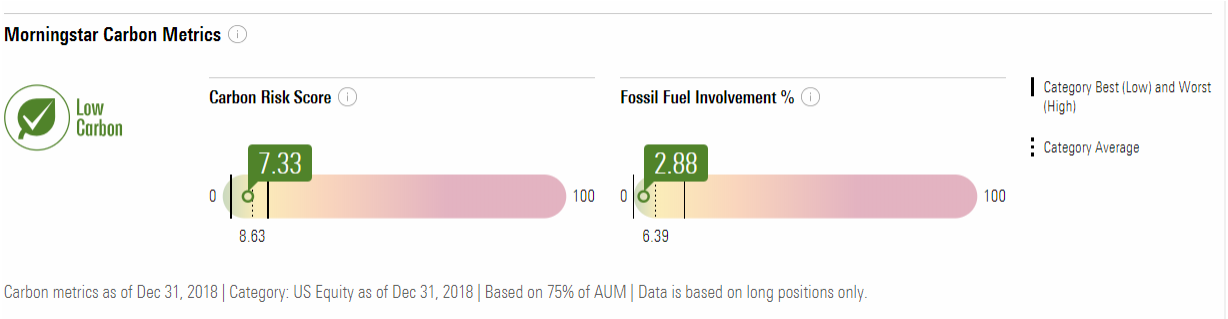
[4]Our paper also relates to the broader literature exploring the effects of product market competition in influencing corporate social responsibility (CSR) practices, e.g., Bartling et al. (2014), Fernández-Kranz and Santaló (2010), Flammer (2015), and Servaes and Tamayo (2013).

[5]A broader stream of research studies the preferences of investors for socially and environmentally responsible firms, primarily through the lens of stock prices (e.g., Hong and Kacperczyk, 2009, Hong and Kostovetsky, 2012, Krüger, 2015, Lins et al., 2017) or through the portfolio holdings of institutional investors (e.g, Dyck et al., 2019, Fernando et al., 2017, Gibson and Krüger, 2017, Gibson et al., 2019, Krüger et al., 2019) or both (Ramelli et al., 2019).

is particularly interesting because it specifically aims at helping clients to easily identify mutual funds with portfolios aligned with the transition to a low-carbon economy.

Details on the methodology underlying the assignment of the LCD are in Morningstar (2018a,b).[6] To receive the LCD, a mutual fund has to comply with two criteria: (1) a 12-month trailing average "Portfolio Carbon Risk Score" below 10 (out of 100); and (2) a 12-month trailing average "Fossil Fuel Involvement" below 7%. The Portfolio Carbon Risk Score is calculated if more than 67% of a fund's portfolio assets (based on the combined market value of bond and equity holdings) have a carbon-risk rating from the ESG research provider Sustainalytics.

Figure 1: Morningstar Direct snapshot



The portfolio scores are based on *issuer-level* variables from Sustainalytics, which are updated on a yearly frequency. According to Sustainalytics, the "Carbon Risk Score" quantifies the portfolio companies' exposure and management of material carbon issues in their operations as well as their products and services (Morningstar, 2018b). The management of carbon issues focuses on portfolio companies' preparedness and track record in managing these issues. In Table A1 in the Appendix, we provide summary statistics of firm-level

[6]For the purpose of our empirical analysis, we take Morningstar's approach to the assessment of funds' climate-related performance as given. Our objective is neither to praise nor criticise Morningstar's methodology, but rather to exploit it to study the behavior of both mutual fund clients and mutual fund managers.

Carbon Risk scores by industries. As expected, firms in high-emitting sectors (e.g., Energy, Materials, and Utilities) are considered those having the highest carbon risks. However, within all sectors, there is substantial variability of this measure.

Morningstar computes the fund-level Carbon Risk scores by weighting the firm-level scores by the total investment (debt and equity) that a mutual fund holds at the end of the quarter in a given company.[7] As of April 2018, having a Portfolio Carbon Risk Score below 10 implies being amongst the 29% of funds with the best performance on this dimension.

"Fossil Fuel Involvement" measures the percentage of portfolio firms that derive a significant share of revenues from activities related to fossil fuels, including thermal coal, oil and gas, oil sands, shale energy, deep-water production, and Arctic offshore exploration. As of April 2018, having a 12-months trailing average Fossil Fuel Involvement below 7% represents a 33% under-weighting of fossil fuel-related companies relative to the global equity universe.

The LCDs were released for the first time at the end of April 2018 and assigned to funds based on their carbon scores as of the end of March 2018. Responding to our clarifying questions, Morningstar representatives noted that they did not communicate in advance the release of the label to either mutual fund managers or their clients. Indeed, the analysis of pre-publication trends further below is in line with the release of the LCD being unexpected. The LCDs for the period from January through the end of April 2018 (pre-publication period) were also released at the end of April 2018, based on the holdings in the previous quarters.

[7] Chen et al. (2019) argue that many managers of fixed-income mutual funds misreport the credit quality of their assets to Morningstar to influence its assessments, in particular the Stars ratings. Contrary to the credit quality of fixed-income assets, the measures underlying the LCD (portfolio carbon risk and portfolio fossil fuel involvement) are not self-reported by fund managers, but are instead computed by Morningstar based on funds' portfolio holdings. Of course, we cannot definitively exclude that some funds decide to misreport their holdings. However, significant legal and reputational risks are associated with such misreporting. Overall, therefore, misrepresentation does not seem to be a major concern in our setting.

Morningstar updates the portfolio aggregates of carbon risk metrics on a quarterly basis, and changes the LCD label assignment accordingly. This setting allows us to study not only the effects of the initial LCD release, but also the effects of later changes.

3 Data

We obtain survivorship-bias-free data for all open-end mutual funds domiciled in Europe and USA, both equity and fixed-income, from Morningstar Direct. Our sample period spans April 2017 (one year before the LCD introduction) through September 2019. Mutual funds issue several share classes to target specific investors groups or geographies, but the underlying portfolio is the same across share classes, and hence so is the Low Carbon Designation. For this reason, all our analyses are conducted at the fund level.[8]

In aggregating data from the share-class to the fund level, we compute funds' returns and volatilities as value-weighted average values across different share classes. Fund assets (in USD) is the sum of the assets under management of a fund in its different share classes. Other fund-level information (including the assignment of the LCD) is retrieved from the largest share class of the funds. Funds with more than 50% of assets in institutional share classes are classified as institutional funds.[9]

Following Sirri and Tufano (1998), flows are computed as the monthly growth of assets

[8]However, our fund-flows results continue to hold when using data at the share-class-level (which allows, for example, for different flows for different share classes), and clustering standard errors at the fund level. For the results on fund responses, no such robustness check can be conducted because all relevant variables only vary on the fund level.

[9]Morningstar classifies as institutional the share classes that meet one of the following criteria: have the word "institutional" in the name; have a minimum initial purchase of USD 100,000 or more; specifically address institutional investors or those purchasing on a fiduciary basis, as stated in the fund prospectus. We define a fund as institutional when more than 50% of assets in share classes are dedicated to institutional clients.

under management net of reinvested returns. To ensure the robustness of our analysis, we trim flows at the 1st and 99th percentiles. Moreover, we compute a measure of normalized flows following Hartzmark and Sussman (2019): First, we split the sample into deciles according to fund size. Second, we rank funds according to their net flows within their size decile and compute percentiles of the net flow rankings. These percentiles correspond to the normalized flows variable.

Throughout the paper, returns are expressed in percentage points. Our main measure of returns is the total monthly return as reported by Morningstar. To obtain a relative measure of returns, we adjusted these for the assets-weighted averages by Morningstar categories (as done, for instance, by Pástor et al., 2017). We also compute CAPM-adjusted and Fama-French-adjusted returns using betas estimate through OLS regressions of monthly data from January 2016 through December 2017.

We compute the return volatility as the standard deviation of returns using a 12-month rolling window. For each fund, we also collect information on the net expense ratio reported in the latest prospectus, age, global category (capturing the investment style), Morningstar's overall rating (the Morningstar "Stars", on a 1-5 scale, with 5 to indicate top financial performers), whether the fund is classified as "socially conscious",[10] and its overall sustainability ratings (the Morningstar "Globes", on a 1-5 scale, with 5 to indicate top sustainability performers).

To account for the impact that "Stars" have on fund flows (Del Guercio and Tkac, 2008), we define the variable ΔStars indicating funds that experienced an upgrade or a downgrade in

[10]Morningstar classifies as socially conscious any fund that identifies itself as investing according to some non-economic guidelines, for instance by excluding certain sectors or companies from the investable universe, or by aiming at selectively investing in good-performing companies based on environmental and social criteria.

the "Star" rating from the previous month, considering observations with continuing missing Stars ratings as no change. Similarly, to account for the impact of the generic sustainability rating (Ammann et al., 2018; Hartzmark and Sussman, 2019), we define the variables Δ1 Globe and Δ5 Globes as the monthly changes of dummy variables indicating funds in the two extreme sustainability categories (1 Globe and 5 Globes), considering the observations with continuing missing sustainability ratings as no change.

- Table 1 -

Panel A of Table 1 shows summary statistics for fund-month observations from April 2017 through September 2019 for which information of flows and LCD is available. Panel B provides a snapshot of the statistics as of the end of April 2018. The sample covers some 20,000 funds, of which around 14% obtained the Low Carbon Designation. The mean net flows in our sample period are negative, partially reflecting the overall shift of mutual fund clients towards index funds and ETFs. The average annual expense ratio is about 1.1 percentage points.[11] 10% of funds self-classify themselves as socially conscious. Interestingly, from the population of socially conscious funds, only a third received the LCD. Around a quarter of all funds are primarily sold to institutional clients.

- Table 2 -

Table 2 shows the geographical distribution of the sample as of the end of April 2018. Around 13,000 funds are domiciled in Europe, and 7,000 are domiciled in the USA. The share of funds that received the initial Low Carbon Designation is 15% in Europe and only

[11] Information on this variable is missing for most of the sample as its annual reporting is compulsory only in the USA. In order not to significantly restrict our European sample, we do not include this variable in our main regressions, but our findings hold even when we do.

12% in the USA. The preference of US funds for local investments partially explains this difference. Since Sustainalytics covers less than 1,000 US firms, many funds do not reach the minimum carbon-risk coverage of 67% of portfolio assets needed to obtain the label.[12]

- Table 3 -

Appendix Table A2 shows the correlations between the variables in our main sample. On average, low-carbon-designated funds have higher assets under management, volatility, and expense ratios. The LCD is also positively correlated with both the Morningstar generic sustainability ratings ("Globes") and the overall performance ratings ("Stars"). However, as shown in Table 3, mutual funds can be awarded the LCD despite having the lowest sustainability rating, or the lowest performance rating. This confirms that the eco-label we study provides investors with information on the climate-related performance of funds that could not be retrieved from other ratings already available on Morningstar.

When studying the active response of mutual fund managers to the LCD release, we exclude from our sample both explicit and closet indexers (around 12% of funds), which do not, by definition, follow active investment strategies.[13] We identify explicit indexers using the Morningstar definition, and closet indexers using the Active Share measures of Cremers and Petajisto (2009) and Cremers et al. (2016). In line with the previous studies, we use an active share below 60% as a cutoff for identifying a closet indexer. However, the portfolios of explicit and closet indexers still provide useful information, since we can use them as a benchmark for the changes we observe in the portfolio holdings of active funds.

[12]If we restrict the sample to cover only eligible funds, we find that both in Europe and USA, 24% of funds receive the LCD. All our subsequent results are virtually unchanged if we focus only on these funds.

[13]As shown by Cremers and Petajisto (2009) and Cremers et al. (2016), a large number of so-called active funds are actually "closet indexers". Such funds are marketed as being actively managed, but their portfolios are mostly allocated passively according to an index.

4 Investors prefer low-carbon funds

This section explores the initial reaction of mutual funds clients to the Low Carbon Designation (LCD). On the one hand, if investors are not concerned about the climate performance of mutual funds or already had other means to express their climate-conscious preferences, we expect to see no effect on fund flows after the introduction of the LCD. On the other hand, if investors do care about the climate-related performance of mutual funds and the LCD allows them to better express these preferences, we expect funds that Morningstar labeled as low-carbon to experience abnormal high flows after April 2018.

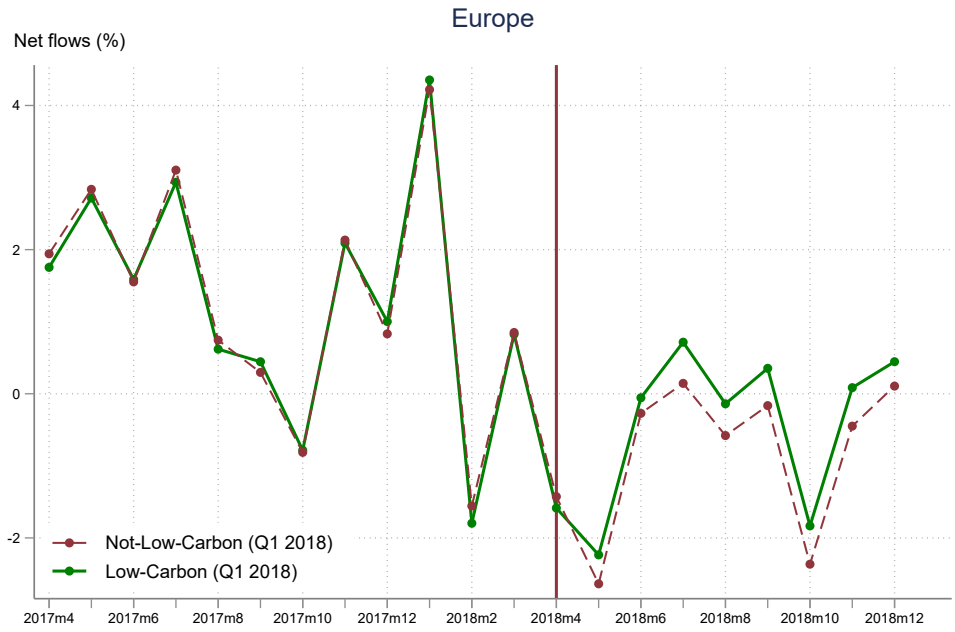
We start this section by graphically depicting flows for low-carbon and not-low-carbon funds. We then formally test whether investors reward low-carbon funds. In the final part of this section, we explore the mechanisms behind the observed effects.

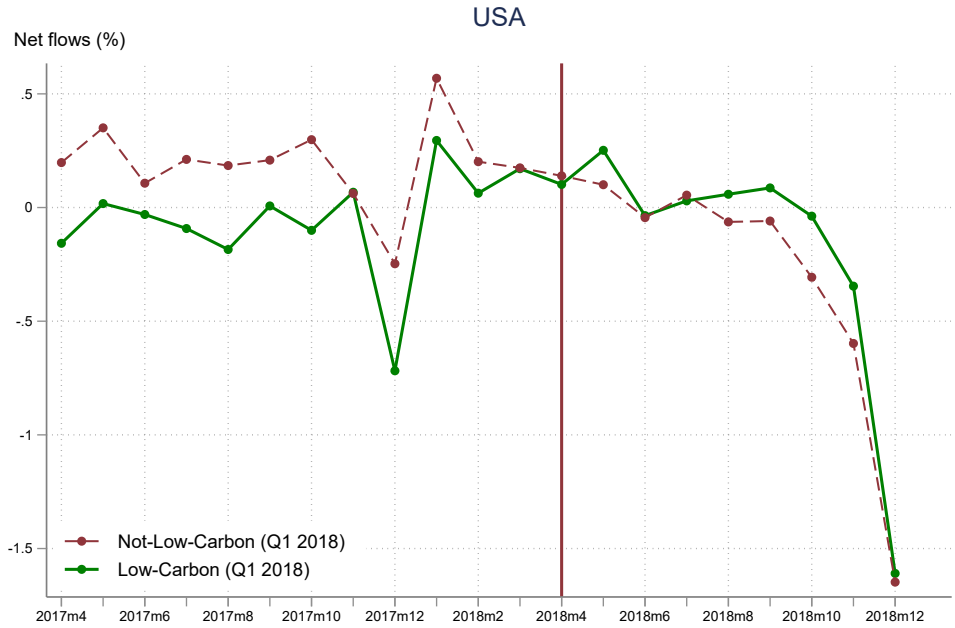
4.1 Graphical evidence

Figure 2 illustrates the average equally-weighted monthly net flows of funds that were categorized as low-carbon at the end of April 2018 and into or out of funds that did not (not-low-carbon), from April 2017 through December 2018. Importantly, information about the LCD became available to investors only from the beginning of May 2018. We call the period April 2017 through April 2018 the pre-publication period. For now, we focus on the post-publication period through December 2018 to document the initial reshuffling of flows caused by the release of the LCD. Section 5.5 investigates the fund-flow effects of LCD upgrades and downgrades over an extended sample period through September 2019.

Figure 2: Effect of the LCD on fund flows

These figures show the equally-weighted average monthly flows of funds designated low-carbon at the end of April 2018 (solid green lines) and of conventional funds (dashed red line) domiciled in Europe (top) and in the USA (bottom), from April 2017 through December 2018. Flows are computed as of end of the month. The Low Carbon Designation was introduced at the end of April 2018.





Consider first the top chart, showing the European sample. During the pre-publication period, the net flows in funds that would be later designated low-carbon are very similar to the average flows in other funds. In other words, the two groups show common trends. (It is a coincidence that in this analysis based on raw data, even the levels closely coincide, though this is not required for the difference-in-differences analysis to be appropriate.) With the release of the LCDs at the end of April 2018, low-carbon-designated funds started enjoying a clear and persistent increase of flows compared to other funds.

In the USA (bottom chart), funds with low-carbon features show lower flows than conventional funds in the pre-publication period but, more importantly, again following very similar fluctuations. Here, too, the release of the LCDs seems to have initiated a relative boost of flows for LCD funds in May 2018. In the following months there was some variation, though by the last four months of 2018, LCD funds had caught up to non-LCD funds in terms of monthly fund flows.

4.2 Empirical strategy

Figure 2 provides suggestive evidence that in the post-publication period, mutual funds that receive the Low Carbon Designation experience higher flows than mutual funds that do not receive it. To formally test that hypothesis, we run the following OLS regression explaining fund i's flows in month t from April 2017 through December 2018:

$$Flows_{i,t} = \alpha + \beta_1 \; LCD_i \; \times \; Post_t + \beta_2 \; LCD_i + \gamma' \mathbf{X_{i,t-1}} + \delta_{\mathbf{i,t}} + \eta_i + \; \epsilon_{i,t}. \qquad (1)$$

The main explanatory variable is the difference-in-differences interaction term $LCD_i \times Post_t$. LCD_i identifies funds that received the LCD at its initial release. $Post_t$ is an indicator variable equal to 1 for months after April 2018, and 0 for all prior months. $\mathbf{X_{i,t-1}}$ is a vector of time-varying lagged fund-level controls that, based on previous literature, may influence fund flows of LCD recipients in a differential manner. These are monthly returns, the logarithm of assets under management, return volatility, the fund's age, the fund's entrance or exit in the two extreme sustainability rating (Globes) categories, and changes of Morningstar's overall assessment of the fund (Stars).[14] $\delta_{\mathbf{i,t}}$ represents month-by-style (Morningstar category) fixed effects. η_i is a set of country dummies (based on the fund's domicile). $\epsilon_{i,t}$ is the error term. Standard errors are clustered along months to account for cross-sectional dependence between observations.

4.3 Regression results

The regression results with our main specification are reported in columns (1), (3), and (6) of Table 4, using the full sample, European funds, and US funds, respectively. The coefficient on the DID interaction term is positive and highly statistically significant in each of the three samples. The coefficient in column (1) indicates that the assignment of the Low Carbon Designation is associated with an average 0.23 percentage points higher difference in net flows compared to the pre-publication period, which corresponds to an increase of eight

[14]We use the change in sustainability and overall ratings rather than the absolute value because, as also noted in Hartzmark and Sussman (2019), if these rating systems are in equilibrium – e.g., existing investors have already sorted in low and high-sustainability funds according to their preferences, after an initial phase of reallocation – there is no reason to expect a continued flows-effect of ratings without further changes. That said, the results also hold just controlling for the number of globes and the number of stars. We also re-run the DID analysis weighting the observations by assets, ruling out the possibility that the coefficients are driven by small funds. The same inferences hold.

percent of the interquartile range of monthly flows. The effect is economically important also when compared to the effect of the main focus of the mutual funds literature so far, returns. A one standard deviation stronger performance in terms of monthly returns yields $3.19 \times 0.15 = 0.48$ percentage points more flows. In other words, the LCD is worth almost half a standard deviation in returns. When compounded over the eight months from May through December 2018, the flow premium associated with the LCD can be quantified in an increase of around 2% in the assets under management.

The coefficients of the control variables are in line with previous literature. In particular, flows are negatively related to age and assets under management, and positively related to past financial performance (Patel et al., 1994).[15]

It is worth noticing that the statistically and economically important net flows boost caused by the LCD happens on top of the effects of the general sustainability ratings documented in Ammann et al. (2018) and Hartzmark and Sussman (2019). We also expand the findings of Del Guercio and Tkac (2008) in our sample period: Upgrades (downgrades) in the Morningstar overall rating (Stars) are followed by a statistically significant increase (decrease) in flows.[16]

To limit the potential effects of size in determining monthly flows, we re-run the main DID analyses using normalized flows as dependent variable. The corresponding regression

[15]Virtually unchanged results are obtained when using the returns adjusted for the average performance by category, also including quarterly and annual returns in the regressions, and using CAPM-adjusted or Fama-French-adjusted returns. We primarily use raw returns because recent research shows that mutual fund investors do not rely on asset pricing models for their investment decisions (Ben-David et al., 2019).

[16]Ben-David et al. (2019) show that Stars ratings are a major determinant of fund flows across US mutual funds, followed only by recent past returns. In Huang et al. (2019), investors rationally respond to changes in Stars ratings even though these ratings, being exclusively based on past financial performance, do not provide them with any new information. In their model, investors take Stars ratings as reputation signals of funds' informational advantage.

results are reported in models (2), (4) and (6) of Table 4. The effect of receiving the Low Carbon Designation is again strongly statistically and economically significant: Net of the effects of control variables, on average, low-carbon funds move up 1.94 percentiles in net flows after April 2018.

- Table 4 -

We conduct a series of robustness checks to ensure the reliability of our findings. First, in Table A3 we ensure that our results hold – and indeed are even larger in magnitude – when adding fund fixed effects to the regressions. Second, we interact all control variables with Post to allow for potential changes over time of the effects on flows of fund characteristics other than the LCD. As shown in Table A4 in the Appendix, the results continue to hold. Third, we add to the regression the two scores used to allocate the LCD – the Portfolio Carbon Risk (CR) and Fossil Fuel involvement (FFI) – and their interaction with Post. This test also provides potential insights into whether investors also responded, conditional on a fund receiving or not receiving the label, to the level of the underlying climate performance. No robust pattern emerges in Table A5 in the Appendix in this respect. Importantly for the purposes of this paper, the results for our main coefficient of interest, the interaction of LCD with Post, remain virtually the same, indicating that it was the LCD that drove investor responses.

Finally, we repeat our analysis using a shorter pre-publication period, starting from December 2017. This allows us to exploit the availability of the LCDs for the period from December 2017 through April 2018, computed by applying the LCD methodology to the historical holdings. This setting allows to further rule out the possibility that the flow-

effect of the LCD may be due to portfolio characteristics not explicitly related to climate performance. Results available on request show that our inferences hold when using the shorter pre-publication period (see Figure A1 in the Appendix for a graphical illustration).

Overall, our findings soundly reject the null hypothesis of no response to the introduction of the Low Carbon Designation. Investors in the mutual fund industry rewarded funds labeled as low-carbon with additional fund flows.

4.4 Why do investors prefer low-carbon funds?

Investors may prefer low-carbon funds mainly for two not-mutually-exclusive reasons: They may interpret the LCD as a signal of stronger future performance and/or they may want to express some climate-conscious preferences.

We first consider the relative financial performance of LCD funds. From Appendix Table A6 we see that, between May 2018 and September 2019, LCD funds, on average, experienced higher abnormal returns than conventional funds, net of the effect of basic fund characteristics (size, volatility, age, and investment style).[17] Although the observation period is too short to make definitive statements regarding performance, this observed outperformance of LCD funds may raise the concern that the flow-effect of the LCD is driven by some already-available information on funds correlated with future returns, information that, however, had nothing to do with climate performance.

To control for this possibility, we run a "perfect foresight" test on our baseline specification. Specifically, we add the fund's *future* quarterly return to the regressions. Obviously,

[17]This relationship holds both for CAPM as well as for Fama-French adjusted returns, where both sets of returns are estimated using monthly regressions from January 2016 through December 2017. An unreported propensity-score matching exercise on fund characteristics also shows that the average LCD fund outperforms a similar Not-LCD fund.

this information was not actually available to investors at that time. The rationale for this exercise is the following. To the extent that our results so far are reflecting investors' anticipation of future performance, or the effect of some unobserved variables correlated with future returns, the effect of the LCD should be absorbed by the coefficient on the actual look-ahead future quarterly return. In Table 5, we find that this is not the case. The regression coefficient on LCD is hardly affected by the addition of future returns. (Similar results are obtained when using CAPM- or Fama-French-adjusted returns.)

- Table 5 -

Next, we investigate whether investors acted on their preferences. To this end, in Table 6, we perform a cross-sectional analysis along some relevant fund characteristics.

- Table 6 -

First, we compare the sub-samples of retail and institutional funds. We expect the introduction of the LCD to have a smaller marginal impact on funds dedicated to institutional clients, as these investors are less likely to rely on an eco-label to take investment decisions. This is because institutional clients ought to have both the means and the ability to compute the climate risk of their investments using other sources. Panel A of Table 6 confirms this conjecture. Both in Europe and in the USA, retail clients of mutual funds are more responsive to the introduction of the LCD than institutional clients.

Second, in Panel B, we compare funds that during the previous quarter had a poor (bottom quartile) financial performance relative to their category to those that had a good (top quartile) relative financial performance. Fund-flow benefits of obtaining the LCD are

significantly higher for poorly performing funds than for strong performers.[18] This behavior is in line with prior works showing that socially- and environmentally-conscious investors are less sensitive to past negative returns than conventional investors (e.g., Benson and Humphrey, 2008, El Ghoul and Karoui, 2017, Renneboog et al., 2011, Riedl and Smeets, 2017).

Finally, in Panel C, we investigate the flows effect of the LCD on low-sustainability (1 or 2 Globes) vs. high-sustainability (4 or 5 Globes) funds. We find that the DID coefficients are significant only for low-sustainability funds. Thus, the funds more likely to benefit from the new eco-label are those not already having other means to target the segment of socially- and environmentally-conscious clients. Investors may interpret obtaining the LCD as a substitute for having a high sustainability rating. However, the substitution is hardly perfect, as seen by the fact that even controlling for Globes changes (or Globes as such), LCD has a distinct and quantitatively important effect.

Overall, our cross-sectional tests are consistent with the fund-flows effect being driven, at least in part, by mutual fund investors having non-pecuniary preferences for climate-conscious investment products.

5 Funds tilt portfolios towards low-carbon firms

The prior section has shown that investors in the mutual fund industry have preferences for climate-conscious investments. Do mutual fund managers react to these revealed preferences?

[18] Similar coefficients are obtained when using the portfolio alphas with respect to the CAPM and Fama-French models. The overall results of the role of prior fund performance are primarily driven by the European sub-sample. One explanation for this could be that, to some extent, US investors view climate-conscious investment combined with poor performance as a signal for agency issues (Barnea and Rubin, 2010).

We expect fund managers that missed the label to compete for flows from climate-conscious investors by shifting their portfolios toward more climate-friendly firms.

We start the section with graphical evidence. We follow this by a formal analysis of how mutual funds move towards low-carbon firms and argue that this is because they compete for flows through climate performance. Finally, we show that the efforts of mutual funds indeed pay off in terms of fund flows.

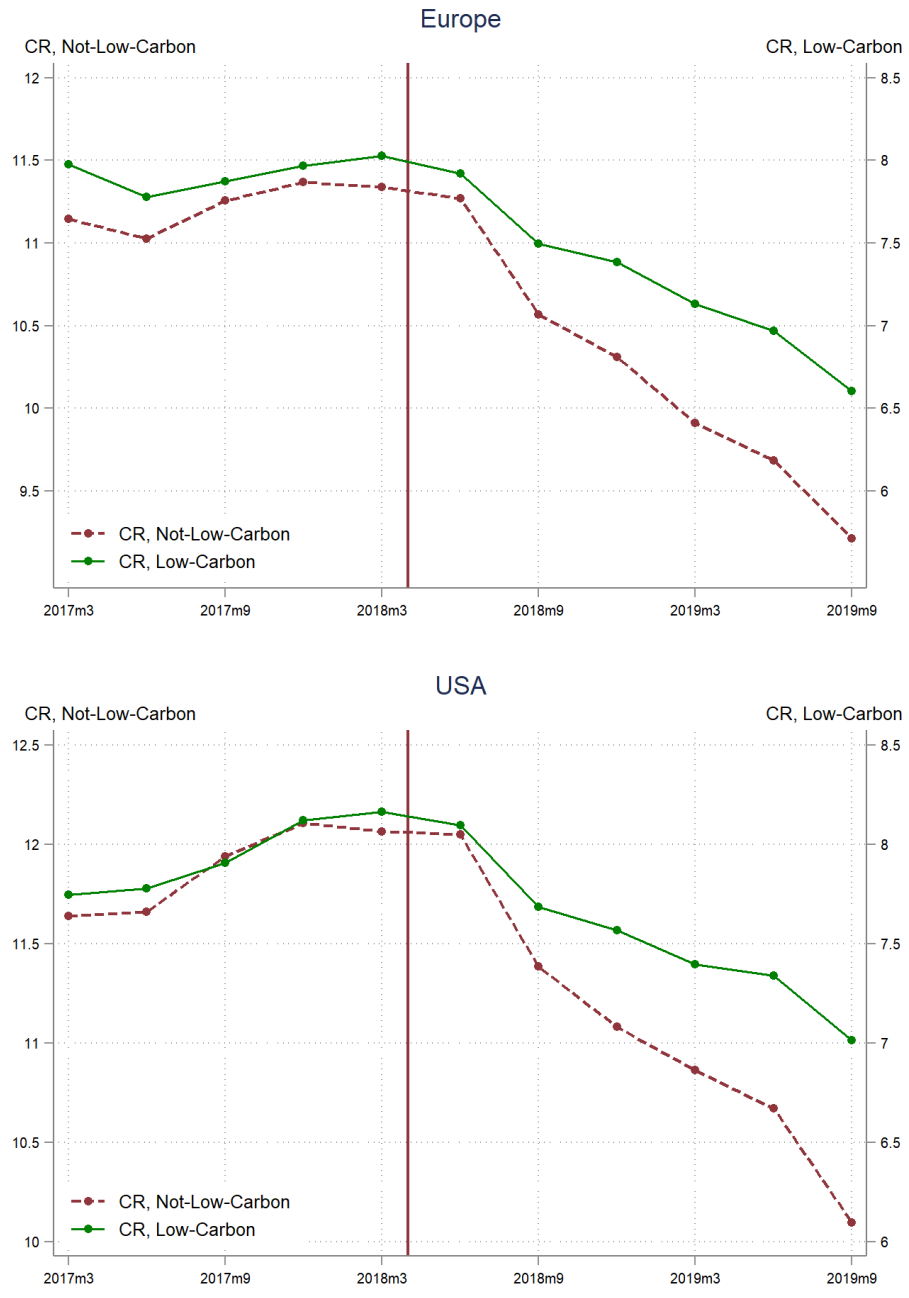
5.1 Graphical evidence

To build intuition, Figure 3 shows coefficients of quarterly regressions of Carbon Risk of active European and US mutual funds over our sample period on NotLCD (an indicator for not receiving the LCD at its introduction) and LCD (an indicator for receiving the label). The regressions also control for category fixed effects.[19]

The figure shows that before the introduction of the LCD, Carbon Risk followed parallel trends in both groups of funds. This suggests that fund managers were not aware of the impending introduction of the label, or at least of the criteria upon which it was awarded. After the introduction of the label, both groups of funds decreased their carbon risk, but the drop in carbon risk is much more pronounced in the NotLCD group.

[19]It is important to control for categories because climate performance varies widely within categories. For example, the average CR for "Energy Sector Equity" funds is 36.7, whereas for "Consumer Goods & Services Sector Equity" it is 6.2.

Figure 3: Mutual funds' responses
This picture depicts the coefficients of quarterly regressions of Carbon Risk on an indicator variable for not receiving the LCD at its introduction, "Not-Low-Carbon", one for receiving the label, "Low-Carbon", and category fixed effects (but no intercept). The first panel uses all active mutual funds (Active Share ≥60%) domiciled in Europe that are not explicit indexers. The second panel uses the same type of funds domiciled in the USA. The sample period is in both cases between March 2017 and September 2019.



5.2 Empirical strategy

To formally test whether the release of the LCD had an effect on mutual funds' behavior, we estimate difference-in-differences regressions. Here, it is intuitive to use as the treatment group those mutual funds that did *not* receive the LCD at its initial release. Specifically, we run the following regression explaining fund i's Carbon Risk in quarter q for quarters March 2017 through September 2019:

$$CR_{i,q} = \alpha + \beta_1 \; NotLCD_i \; \times \; Post_q + \beta_2 \; NotLCD_i + \gamma' \mathbf{X_{i,q-1}} + \delta_{\mathbf{i,q}} + \eta_i + \; \epsilon_{i,t}. \qquad (2)$$

The main explanatory variable is the difference-in-differences interaction term $NotLCD_i \times Post_q$. $NotLCD_i$ identifies funds that did not receive the LCD at its initial release. $Post_q$ is an indicator variable equal to 1 for the quarters the LCD was in place, i.e., 2018-Q2 through 2019-Q2, and 0 for all prior quarters. $\mathbf{X_{i,q-1}}$ includes time-varying lagged fund-level controls, quarterly returns, the logarithm of assets under management, return volatility, and the fund's age.[20] $\delta_{\mathbf{i,q}}$ includes quarter-by-style (Morningstar category) fixed effects. η_i is a set of country dummies (based on the fund's domicile). $\epsilon_{i,q}$ is the error term.

Besides rebalancing activities, there are two additional ways through which the climate performance of mutual funds may change. First, these can originate from changes in the underlying carbon risk of firms. Second, they can originate from changes in market values of portfolio assets. We can exclude the first channel for most of our sample period since Sustainalytics updates the firms' climate scores on a yearly frequency, and all portfolio

[20] Our results remain virtually unchanged if we add the fund's entrance or exit in the two extreme sustainability rating (Globes) categories, and changes of Morningstar's overall assessment of the fund (Stars) to the regressions. We choose not to include these variables, as they could vary as a consequence of funds adjusting their climate-performance.

scores up to Q1-2019 are based on the firm-level carbon performance of 2017.[21] To account for the second channel, similarly to Leippold and Rueegg (2019), we benchmark the climate performance of active funds with that of funds that by definition, do *not* actively rebalance their portfolios, i.e., outright and closet indexers (together called passive funds).

Thus, for each quarter, *abnormal* CR is computed as the difference between the active fund's climate performance and the average climate performance of the passive funds in the same category. This way, we account for systematic differences between categories and across time. Additionally, to capture differences in levels, we perform the adjustment by the degree to which a fund fulfills the criteria for obtaining the LCD, i.e., ∅CR≤10, ∅FFI≤7%. We summarize this computation in equation 3 below.

$$AbnCR^{\tau}_{i,q,k} = CR^{\tau}_{i,q,k} - \varnothing CR^{Passive,\tau}_{q,k}, \forall \text{ fund } i, \text{ quarter } q, \text{ category } k, \text{ and } \tau \in \{\varnothing\text{CR} \leq 10,\ \varnothing\text{FFI} \leq 7\%, \text{ both, neither.}\} \tag{3}$$

Analogously to equations 2 and 3, we also run regressions explaining (abnormal) Fossil Fuel Involvement.

5.3 Regression results

The regressions using (gross) Carbon Risk as the dependent variables are reported in columns (1), (3), and (5) of Panel A of Table 7, using the full sample, European funds, and US funds respectively. Columns (2), (4), and (6) use as dependent variable the abnormal climate performance, i.e., after controlling for the average CR of passive funds.

- Table 7 -

[21] Our results remain virtually unchanged if we drop the observations from 2019.

Throughout, the coefficient on the DID interaction term is negative and highly statistically significant in each of the three samples. For example, the coefficient in column (1) indicates that not receiving the LCD at its initial release is associated with an average decrease in CR of 0.48 (11% of a standard deviation) above that observed in funds that received the LCD in April 2018. The size of the effect is similar in European and US funds. Moreover, when we account for differential changes in market capitalization of the underlying assets in columns (2), (4), and (6), we find that the size of the coefficient is smaller, but the economic significance is somewhat stronger (13% of a standard deviation).

To better understand how funds achieved this change and to assess the economic significance of these changes, in Table 8 we study the % Assets Under Management that funds held in negligible, low, medium, high, and severe Carbon Risk (CR) firms. These categories correspond to firms with a CR score of 0, 0.01-9.99, 10-29.99, 30-49.99, and >50 respectively. To lower the CR of their portfolios, fund managers increased their holdings in negligible and low CR firms by 0.81% and 0.94% and reduced their holdings in medium, high, and severe CR firms by 0.98%, 0.34%, and 0.21% per quarter. In other words, both new investments in low-carbon-risk assets and divestments from high-carbon-risk assets contributed to the overall result.

- Table 8 -

Panel B of Table 7 reveals a similar picture for fossil fuel involvement. Overall, when compared to funds that received the LCD, Not-LCD funds under-weighted their FFI by 0.29% (4% of a standard deviation) per quarter, or 1.75 percentage points when aggregated over the six quarters the LCD was in place. The size of the coefficient in the USA is in line with

the results in the European and the full sample. When we account for differential changes in market capitalization in columns (2), (4), and (6), we find that the actual improvement amounts to a 0.90% decrease in Abnormal FFI (16% of a standard deviation). The reason why adjusting for market trends is particularly important for FFI is that, in contrast to Carbon Risk, this variable is sector-specific and particularly prone to market swings.[22] We remove this bias when we control for the climate-performance of passive funds. The coefficients of Abnormal FFI in all samples are significant, though European funds appear to reduce their FFI slightly more aggressively.

We conduct a series of checks to ensure the reliability of our findings. Panel A of Appendix Table A7 includes Fund FEs to the baseline specification. We do this to account for potential omitted variables that remain constant for a given fund. Despite having a brief time series, the coefficients of our analysis remain significant, albeit slightly smaller. Panel B runs a fully interacted model of our baseline regression. We interact all controls with Post to allow for a change in the way the covariates interact with the climate performance of funds before and after the LCD was introduced. Our findings remain robust to this specification as well. These robustness tests mitigate omitted variables and selection bias concerns.

Overall, the evidence provided in this section is consistent with fund managers responding to the revealed preferences of their clients by improving the climate-performance of their portfolios.

[22] Consider an energy sector fund with a FFI of 70% and USD 100m in assets under management. Suppose that the fossil-fuel dependent stocks in its portfolio were to halve in value, whereas the value of the other stocks remains unchanged. If the fund were passive, its FFI would now be 0.5*70m /(0.5*70m + 30m), around 54%.

5.4 Is the response of funds strategic?

What might drive fund managers' behavior? While it is difficult to infer the motivations of fund managers from the regressions, additional tests yield some insights. If the response of fund managers is strategic, it ought to be stronger when, first, adjusting portfolio climate-performance is easier and, second, when there is more to gain from obtaining the additional visibility tied to receiving the label.

First, fund managers should be better able to improve their climate-performance when they had high flows in the previous quarter, as this will give them additional room for maneuver. In Panel A of Table 9, we split the sample along the top and bottom quartiles of fund flows in the quarter before the LCD was introduced. The coefficients in the first two models are negative but smaller than the corresponding ones in the last two models. This supports that having experienced high flows in the previous quarter enhances the ability of funds to improve their climate performance.[23]

Second, young funds should have a stronger incentive to get the label since they are less known. The LCD could help them attract the attention of climate-conscious investors.[24] In Panel B of Table 9, we split the sample based on fund age into young (bottom quartile) and old (top quartile) funds. Young funds reduce their Abnormal CR and FFI almost three times more than old funds do, confirming our hypothesis.

- Table 9 -

Taken together, these findings suggest that mutual fund managers see obtaining the LCD as a way to compete for the flows of climate-conscious investors.

[23] We find a similar effect when splitting the sample based on past abnormal performance.

[24] Wahal and Wang (2011) show that the competitive behavior of new entrant funds is particularly intense.

5.5 Do funds' efforts pay off?

We have shown that investors value climate responsibility, and that in response, mutual fund managers adjust their holdings. Do these reallocation efforts of fund managers pay off in the sense that they are able to attract additional flows beyond the initial LCD release?

Morningstar updates the LCD on a quarterly basis, with one-month delay from the end of the quarter. Our sample period covers five quarterly updates in the post-publication period. As shown in Panel A of Table 10, while the large majority of funds had their LCD classification confirmed, in each of these updates a small fraction of funds did switch from LCD to not-LCD, or vice-versa. What are the effects of these LCD upgrades and downgrades?

We define, for each fund, the indicators *LCD Downgrade* and *LCD Upgrade*. These binary indicators are equal to 1 for months following an LCD downgrade or upgrade, respectively, and 0 otherwise. The results in Panel B of Table 10 indicate that subsequent LCD upgrades and downgrades also have a significant impact on net flows. This is particularly the case for European funds. In the USA, where there are fewer "switchers" compared to the European sample, only the coefficient on LCD upgrades is statistically significant.

- Table 10 -

Overall, these result indicate that managers of funds that are not considered low-carbon can potentially access an important source of flows as long as they manage to rebalance their portfolios in a climate-responsible direction successfully.

6 Low-carbon funds have higher idiosyncratic risk

One traditional argument against responsible investing is that the adoption of environmental and social criteria restricts the investable universe, hence preventing risk sharing from a mean-variance perspective (Markowitz, 1952).[25] Contrary to this view, some evidence suggests that sustainable funds can obtain lower idiosyncratic risk than conventional funds by picking, within each sector, companies with lower firm-specific risks.[26] This debate raises the question whether LCD funds have lower or higher idiosyncratic volatility than other funds.

We compute a fund's idiosyncratic risk as the standard deviation of monthly residuals from a Fama-French three-factor model run over the post-publication period from May 2018 through September 2019.[27] We require at least 9 observations of monthly returns.

In Table 11, we then regress idiosyncratic risk on LCD and controls. In these regressions, we also include the manager's tenure to account for potential effects of career concerns on the manager' willingness to hold unsystematic risks (Chevalier and Ellison, 1999).

- Table 11 -

In column (1), we find that investors in LCD funds experience a 23 basis points *higher* idiosyncratic risk than otherwise-similar conventional funds. This difference is economically meaningful as it corresponds to 16% of the median idiosyncratic risk. Adding controls for categories and for the Active Share explains some of the difference in risk, but a sizable difference remains even with all controls included (see columns (2) to (4)).

[25]For instance, Geczy et al. (2005) study the diversification cost of investing in socially responsible funds over the period 1963-2001. They provide evidence of significant costs, in terms of lower certainly-equivalent returns, of imposing SRI constraints in the portfolio construction.

[26]For instance, Godfrey et al. (2009) show that firms with more advanced CSR practices have lower idiosyncratic volatility.

[27]Very similar results are obtained when looking at funds' volatilities over the full sample period.

By contrast, funds with 4 or 5 Globes, i.e., funds receiving a high generic sustainability rating, have *lower* idiosyncratic risk than their less sustainable peers. The contrasting effects on idiosyncratic volatility of the Morningstar Globes and the LCD are due to a key methodological difference of these two labels: While the Globes are assigned within each category based on "best-in-class" sustainability scores, the LCD rewards funds that under-weight or avoid carbon-intensive sectors. The higher volatility of LCD funds emerges as a natural by-product of their smaller sectoral diversification.

This result raises a cautionary flag regarding possible unintended effects of this type of eco-labels. Donaldson and Piacentino (2018) model how mutual funds compete for flows on the base of public information, e.g., by committing to invest exclusively in AAA-rated assets. Such competition lowers the overall welfare of investors by preventing risk sharing.[28] Similarly, in our setting, competing for flows through climate responsibility may give rise to social inefficiencies insofar as the incentives created by the label trigger a "race to the bottom" in terms of portfolio diversification. This effect should be assessed alongside the "race to the top" in terms of reduction of climate-related risks documented in Section 5.

7 Conclusion

Around the introduction of Morningstar's Low Carbon Designation (LCD) label in April 2018, mutual funds directly experienced the intensity of investors' preferences for climate-responsible investments: Keeping other factors constant, funds labeled as low-carbon enjoyed

[28]This finding relates to the broader literature studying asset management in a principal-agent framework. For other relevant works on how fund managers strategically adjust the riskiness of the portfolio in response to incentive considerations, see Chevalier and Ellison (1997) and Palomino and Prat (2003).

a cumulated relative increase of 2% of assets under management from May through the end of December 2018 relative to funds that were not labeled as low-carbon. Effectively, investors valued climate performance (receiving the LCD) as being equivalent to one half of a standard deviation of financial performance.

Changes in culinary habits and trends inspire chefs worldwide to adapt their menus to the new preferences of their clients. Similarly, with the chefs of the financial industry, investors' call for a low-carbon diet in their portfolios did not fall on deaf ears: Mutual funds that initially did not receive the LCD subsequently reduced (increased) their holdings in high (low) carbon-intensity companies. In other words, the incentives created by the release of the LCD accelerated climate-related investment strategies in the mutual fund industry.

The high-carbon assets shunned by mutual funds seeking to be considered low-carbon do not disappear, but are picked up by other investors. However, this type of divestment is likely to increase the cost of capital for high-carbon firms, much like the divestment from "sin stocks" by certain norm-constrained investors increases the cost of capital (and the expected returns) of companies involved in alcohol, tobacco, or gambling-related activities (Hong and Kacperczyk, 2009). Whether and how this will induce high-carbon firms to attempt to convert their business models toward cleaner business activities remains unclear.[29] A full analysis, including welfare considerations, is outside the scope of this paper. Even with this caveat, we believe that the results have important implications for fund managers, policy-makers and investors. First, they alert active fund managers to the importance of sustainability as a key competitive edge, especially in light of the return and fee pressure

[29]For instance, in Oehmke and Opp (2020) socially responsible investors can indeed lead firms to adopt clean production technologies, but only under certain conditions. In particular, in their model, socially responsible investors need to have a broad mandate – i.e., the ability to also invest in "dirty" firms – in order to generate impact.

coming from index funds and ETFs. Second, our analyses can inform policy-makers and investors of the potential effectiveness of eco-labeling schemes in re-orienting capital flows. On the one hand, they "work" in the sense of inducing desired behavioral responses of financial intermediaries. On the other hand, certain designs of eco-labels – such as the LCD – incentivize funds to reduce diversification, to the detriment of investors who do not consequently adjust their portfolios. Effective instruments utilize the competitive behavior of financial intermediaries to accelerate the transition to a low-carbon economy, but should avoid such undesired effects.

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Tables

Table 1: Descriptive statistics
Descriptive statistics of active mutual funds domiciled in Europe and USA for which information on the Low Carbon Designation (LCD) and flows is available. Panel A covers all fund-month observations from April 2017 through September 2019, while Panel B provides a snapshot as of the end of April 2018. LCD is a dummy variable indicating funds that obtained the Low Carbon Designation at the end of April 2018. CR and FFI are the funds' carbon risk and fossil fuel involvement. Abn CR and Abn FFI are the funds' climate performance after controlling for differential market performance. Flows (in percentage points) is the monthly growth of assets net of reinvested returns. Normalized flows are computed following Hartzmark and Sussman (2019). Return is the monthly net return. Log assets is the log of AUM in USD. Volatility is the standard deviation of returns in the previous 12 months. Expense ratio is the annual percentage of assets deducted for fund expenses. Age is the number of years since the inception of the oldest share class. Globes is the Morningstar sustainability rating on a 1-5 scale. Stars is the overall Morningstar rating system on a 1-5 scale. Δ1 Globe and Δ5 Globes indicate funds entering (1) or exiting (-1) the 1 Globe and 5 Globes category in a given month. ΔStars indicates if a fund received a downgrade or an upgrade in the Morningstar rating system (Stars). Socially conscious is a dummy variable for funds that label themselves as socially conscious in either their name or prospectus. Institutional is a dummy variable for funds with more than 90% of assets in institutional share classes. Idiosyncratic risk is the standard deviation of residuals from a Fama-French three-factor model run over the period from May 2018 through September 2019, for funds with at least 9 observations of monthly returns.

Panel A: From April 2017 through September 2019

	N	min	p25	mean	p50	p75	max	sd
LCD	584,654	0.00	0.00	0.14	0.00	0.00	1.00	0.35
CR	314,976	0.00	8.60	10.70	10.38	12.18	58.59	4.48
FFI	502,524	0.00	1.95	6.70	5.31	8.86	100.00	8.07
Abn CR	117,963	-32.87	-1.01	0.02	-0.06	0.96	35.49	2.49
Abn FFI	180,029	-89.84	-2.33	-0.48	-0.45	1.18	83.20	5.71
Flows	584,654	-19.55	-1.60	0.04	-0.24	1.28	30.68	4.16
Normalized flows	584,654	1.00	26.00	49.96	50.00	74.00	100.00	27.99
Return	584,654	-99.71	-0.83	0.38	0.43	1.93	26.59	3.19
Log assets	584,654	4.69	17.10	18.55	18.56	19.97	26.02	2.03
Volatility	584,654	0.00	1.29	2.55	2.33	3.48	28.72	1.64
Expense ratio	314,293	-0.25	0.67	1.09	1.01	1.42	15.15	0.67
Age	584,654	0.16	5.45	13.55	11.84	19.08	119.32	10.20
Globes	392,887	1.00	2.00	3.05	3.00	4.00	5.00	1.13
Stars	364,201	1.00	2.00	3.20	3.00	4.00	5.00	1.06
Δ1 Globe	584,654	-1.00	0.00	-0.00	0.00	0.00	1.00	0.13
Δ5 Globes	584,654	-1.00	0.00	0.00	0.00	0.00	1.00	0.13
ΔStars	584,654	-1.00	0.00	-0.00	0.00	0.00	1.00	0.30
Socially conscious	584,654	0.00	0.00	0.10	0.00	0.00	1.00	0.31
Institutional	584,654	0.00	0.00	0.24	0.00	0.00	1.00	0.43

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Panel B: End of April 2018

	N	min	p25	mean	p50	p75	max	sd
LCD	20,077	0.00	0.00	0.14	0.00	0.00	1.00	0.35
CR	11,879	0.00	9.22	11.20	10.88	12.60	57.26	4.50
FFI	19,369	0.00	1.89	6.39	5.06	8.49	100.00	7.75
Abn CR	11,385	-32.87	-0.90	0.10	0.00	1.00	35.49	2.59
Abn FFI	17,551	-85.70	-2.03	-0.34	-0.37	1.21	67.30	5.69
Flows	20,077	-19.39	-2.26	-0.89	-1.37	0.04	30.48	3.99
Normalized flows	20,077	1.00	26.00	50.15	50.00	74.00	100.00	28.07
Return	20,077	-9.79	0.03	1.59	1.18	3.03	15.91	2.23
Log assets	20,077	5.29	17.13	18.57	18.58	19.99	25.93	2.03
Volatility	20,077	0.00	1.24	2.09	2.22	2.76	16.21	1.11
Expense ratio	10,492	-0.21	0.67	1.10	1.01	1.42	14.53	0.69
Age	20,077	0.16	5.05	13.20	11.46	18.73	118.24	10.21
Globes	13,567	1.00	2.00	3.02	3.00	4.00	5.00	1.14
Stars	15,223	1.00	3.00	3.21	3.00	4.00	5.00	1.06
Δ1 Globe	20,077	-1.00	0.00	-0.00	0.00	0.00	1.00	0.14
Δ5 Globes	20,077	-1.00	0.00	0.00	0.00	0.00	1.00	0.14
ΔStars	20,077	-1.00	0.00	0.00	0.00	0.00	1.00	0.33
Socially conscious	20,077	0.00	0.00	0.10	0.00	0.00	1.00	0.31
Institutional	20,077	0.00	0.00	0.24	0.00	0.00	1.00	0.43
Idiosyncratic risk	19,982	0.00	0.80	1.67	1.43	2.27	49.35	1.29

Table 2: Geographical distribution of funds
This table shows the geographical distribution of funds included in the sample, with the share of funds that obtained the Morningstar Low Carbon Designation. Standard deviations and 25th, 50th, and 75th percentiles of flows for each area are reported to facilitate the interpretation of regression results that follow. The table covers all funds included in the sample as of April 2018. Portfolio Carbon Risk Scores are assigned by Morningstar only to funds with more than 67% of portfolio assets in companies covered by Sustainalytics in terms of carbon-risk rating (Morningstar, 2018b).

			Flows			
Area of domicile	N	Fraction of LCD funds	p25	p50	p75	sd
Europe	13,073	0.15	-2.71	-1.80	-0.62	4.07
USA	7,004	0.12	-1.12	-0.28	0.72	3.62
Total	20,077	0.14	-2.26	-1.37	0.04	3.99

Table 3: Morningstar LCD, sustainability, and overall ratings
This table shows the absolute frequencies of funds without and with the Low Carbon Designation (LCD) along the Morningstar sustainability "Globes" ratings (Panel A) and the Morningstar overall "Stars" ratings (Panel B) as of April 2018.

Panel A: Morningstar sustainability ratings ("Globes")

LCD	1	2	3	4	5	Total
0	1,232	2,495	3,817	2,388	1,078	11,010
1	216	433	819	682	407	2,557
Total	1,448	2,928	4,636	3,070	1,485	13,567
% of LCD funds	14.92%	17.35%	18.77%	22.21%	27.41%	18.85%

Panel B: Morningstar overall ratings ("Stars")

LCD	1	2	3	4	5	Total
0	755	2,481	4,643	3,505	1,427	12,811
1	96	431	804	729	352	2,412
Total	851	2,912	5,447	4,234	1,779	15,223
% of LCD funds	11.28%	14.80%	14.76%	17.22%	19.80%	15.84%

Table 4: Investors prefer low-carbon funds

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period). The sample includes all active mutual funds domiciled in Europe or USA, excluding 729 funds that experienced an LCD upgrade or downgrade in August or November 2018. Models (1), (3) and (5) use monthly net flows as the dependent variable, while models (2), (4), and (6) use monthly normalized flows. All regressions control for month-by-style and country fixed effects. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered at month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.23***	1.95***	0.28***	2.31***	0.18**	1.50**
	(3.66)	(3.09)	(3.95)	(3.25)	(2.33)	(2.78)
LCD	0.14***	1.18***	0.07*	0.78**	0.25***	1.87***
	(4.67)	(4.36)	(1.97)	(2.60)	(6.10)	(6.52)
Return	0.15***	1.04**	0.15***	1.02***	0.21***	1.59***
	(3.77)	(2.54)	(4.79)	(3.01)	(8.18)	(6.68)
Log assets	-0.01	0.87**	0.00	1.03***	-0.02**	0.81**
	(-1.72)	(2.60)	(0.67)	(2.99)	(-2.51)	(2.35)
Volatility	0.02	0.30	-0.00	-0.07	-0.02	0.39
	(0.40)	(0.77)	(-0.01)	(-0.20)	(-0.31)	(1.07)
Age	-0.05***	-0.43***	-0.05***	-0.39***	-0.05***	-0.48***
	(-19.04)	(-28.10)	(-15.30)	(-22.97)	(-22.88)	(-24.75)
Δ1 Globe	-0.07	-0.21	-0.03	0.10	-0.08	-0.10
	(-1.14)	(-0.64)	(-0.39)	(0.27)	(-0.99)	(-0.18)
Δ5 Globes	0.10	0.44	0.08	0.36	0.07	-0.21
	(1.33)	(0.72)	(1.28)	(0.69)	(0.90)	(-0.40)
ΔStars	0.08***	0.39	0.10**	0.48*	0.05*	0.20
	(2.87)	(1.70)	(2.44)	(1.83)	(2.06)	(0.83)
Observations	396,398	396,398	255,579	255,579	140,767	140,767
R-squared	0.14	0.12	0.19	0.12	0.07	0.21
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Why do investors react? Part 1: Anticipation of future performance
This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018. Future quarterly return is the fund's forward return in the next three months. t-statistics, based on robust standard errors clustered along month, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
Dep. variable:	(1) Flows	(2) Normalized flows	(3) Flows	(4) Normalized flows	(5) Flows	(6) Normalized flows
LCD × Post	0.22***	1.92***	0.27***	2.27***	0.17**	1.48**
	(3.55)	(3.03)	(3.83)	(3.15)	(2.25)	(2.77)
LCD	0.13***	1.14***	0.07*	0.74**	0.25***	1.77***
	(5.10)	(4.54)	(1.90)	(2.55)	(5.57)	(6.06)
Future quarterly return	0.02	0.14	0.03	0.19	0.01	0.16*
	(1.09)	(0.71)	(1.67)	(1.09)	(1.26)	(1.86)
Observations	393,577	393,577	253,656	253,656	139,867	139,867
R-squared	0.14	0.12	0.19	0.12	0.07	0.21
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Why do investors react? Part 2: Investor preferences

This table shows results of OLS regressions of monthly flows from April 2017 through December 2018 exploring the differential effect of the LCD in different sub-samples: for retail vs. institutional funds (Panel A); for poor vs. good past financial performers (Panel B); and for low vs. high sustainability rated funds (Panel C). Poor (good) past financial performers are funds with an adjusted return (based on their Morningstar category) in the last three months in the bottom (top) quartile. Low (high) sustainability-rated funds are funds with 1 or 2 (4 or 5) Morningstar sustainability globes. All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered along month, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Retail vs. institutional funds

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Flows	Flows	Flows	Flows	Flows
	Retail	Institutional	Retail	Institutional	Retail	Institutional
LCD × Post	0.25***	0.18**	0.29***	0.24	0.20**	0.14
	(3.12)	(2.35)	(3.22)	(1.60)	(2.25)	(1.32)
LCD	0.08**	0.32***	0.02	0.30***	0.21***	0.33***
	(2.64)	(6.84)	(0.61)	(3.86)	(4.21)	(5.33)
Observations	299,981	96,361	221,197	34,267	78,725	61,998
R-squared	0.17	0.10	0.21	0.17	0.08	0.08

Panel B: Poor vs. good past performing funds

	Poor	Good	Poor	Good	Poor	Good
LCD × Post	0.33***	0.16	0.55***	0.12	0.06	0.25
	(3.77)	(0.91)	(4.08)	(0.71)	(0.27)	(1.26)
LCD	0.16**	0.11	-0.13	0.12*	0.56***	-0.01
	(2.60)	(1.67)	(-1.28)	(1.81)	(5.42)	(-0.11)
Observations	81,112	80,738	52,037	51,934	29,036	28,910
R-squared	0.14	0.19	0.19	0.23	0.10	0.10

Panel C: Low vs. high sustainability rated funds

	Low sust.	High sust.	Low sust.	High sust.	Low sust.	High sust.
LCD × Post	0.41***	0.06	0.43***	0.10	0.29	0.09
	(2.98)	(0.78)	(2.90)	(1.26)	(1.66)	(0.81)
LCD	0.17**	0.27***	0.09	0.25***	0.34***	0.22**
	(2.60)	(5.06)	(1.17)	(4.50)	(3.29)	(2.60)
Observations	84,121	88,126	59,291	62,635	24,801	25,454
R-squared	0.15	0.15	0.18	0.20	0.11	0.09
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: Funds tilt portfolios towards low-carbon firms

This table shows results of OLS difference-in-differences (DID) regressions of quarterly gross and Abnormal Carbon Risk (CR and Abn CR) from March 2017 through September 2019 on the interaction between the dummy NotLCD (funds that did not receive the LCD at the initial release) and the dummy Post (period after April 2018). Panel B shows the regressions for quarterly gross and Abnormal Fossil Fuel Involvement (FFI and Abn FFI). Abnormal climate performance metrics (indicated by Abn) are constructed to account for price changes by subtracting for each category-month pair the mean CR and FFI of explicit indexers and passive investors (Active Share $\leq$60%). We compute the means separately by the degree to which the treatment criteria are fulfilled, i.e., $\varnothing$CR$\leq$10, $\varnothing$FFI$\leq$7, both, and none. The sample includes all active mutual funds domiciled in Europe or USA. All regressions control for quarter-by-style fixed effects and lagged fund-level controls. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered along fund, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Carbon Risk

	Full sample		Europe		US	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	CR	Abn CR	CR	Abn CR	CR	Abn CR
NotLCD × Post	-0.48***	-0.31***	-0.46***	-0.29***	-0.50***	-0.31***
	(-13.83)	(-8.49)	(-11.32)	(-7.01)	(-7.44)	(-4.26)
Observations	86,063	86,063	57,846	57,846	28,206	28,206
R-squared	0.71	0.19	0.69	0.24	0.79	0.23

Panel B: Fossil Fuel Involvement

	Full sample		Europe		US	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	FFI	Abn FFI	FFI	Abn FFI	FFI	Abn FFI
NotLCD × Post	-0.29***	-0.90***	-0.26***	-0.98***	-0.33**	-0.60***
	(-4.15)	(-12.46)	(-3.16)	(-11.61)	(-2.47)	(-4.41)
Observations	86,063	86,063	57,846	57,846	28,206	28,206
R-squared	0.66	0.37	0.59	0.39	0.78	0.39
Constant & controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE fund	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Mutual funds' responses - Changes in portfolio composition
This table shows results of OLS difference-in-differences (DID) regressions of the % of assets under management that mutual funds in negligible, low, medium, high, and severe Carbon Risk (CR) firms from March 2017 through September 2019 on the interaction between the dummy NotLCD (funds that did not receive the LCD at the initial release) and the dummy Post (period after April 2018). These categories correspond to a CR score of 0, 0.01 - 9.99, 10 - 29.99, 30 - 49.99, and >50 respectively. The sample includes all active mutual funds domiciled in Europe or USA. All regressions control for quarter-by-style fixed effects and lagged fund-level controls. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered along fund, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Dep. variable:	(1) % Negligible CR	(2) % Low CR	(3) % Medium CR	(4) % High CR	(5) % Severe CR
NotLCD × Post	0.81*** (5.10)	0.94*** (6.28)	-0.98*** (-3.70)	-0.34*** (-5.89)	-0.21*** (-4.21)
Observations	77,760	79,640	30,269	59,606	32,653
R-squared	0.62	0.37	0.54	0.61	0.57
Constant & controls	Yes	Yes	Yes	Yes	Yes
Quarter-Style FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Clustered SE fund	Yes	Yes	Yes	Yes	Yes

Table 9: Which mutual funds react most strongly?
This table presents results of OLS difference-in-differences (DID) regressions of quarterly Abnormal Carbon Risk (Abn CR) and Abnormal Fossil Fuel Involvement (Abn FFI) from March 2017 through September 2019 on the interaction between the dummy NotLCD (funds that did not receive the LCD at the initial release) and the dummy Post (period after April 2018). Panel A compares funds in the bottom and top quartile of the performance distribution (category-adjusted returns in the quarter prior to the LCD introduction). Panel B compares funds whose flows in the quarter prior to the introduction of the LCD were in the bottom or top quartile. Panel C compares young and old funds (age ≤25-th vs. age ≥75-th percentile). Panel D compares funds that had either no or small (≤25-th percentile) 12b-1 marketing and distribution fees with funds that had larger (>25-th percentile) 12b-1 fees. Abnormal climate performance metrics (indicated by Abn) are constructed to account for price changes by subtracting for each category-month pair the mean CR and FFI of explicit indexers and passive investors (Active Share ≤60%). We compute the means separately by the degree to which the treatment criteria are fulfilled, i.e., ∅CR≤10 only, ∅FFI≤7 only, both, and none. The sample includes all active mutual funds domiciled in Europe or USA. All regressions control for quarter-by-style fixed effects and lagged fund-level controls. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered along fund, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Flows in previous quarter

	Bottom quartile		Top quartile	
	(1)	(2)	(3)	(4)
Dep. variable:	Abn CR	Abn FFI	Abn CR	Abn FFI
NotLCD × Post	-0.10	-0.41**	-0.27***	-1.00***
	(-1.03)	(-1.99)	(-2.65)	(-4.16)
NotLCD	0.40**	0.76***	0.53***	0.54**
	(2.31)	(3.46)	(3.21)	(2.07)
Observations	9,857	9,857	9,887	9,887
R-squared	0.37	0.47	0.19	0.35

Panel B: Fund age

	Young		Old	
	(1)	(2)	(3)	(4)
Dep. variable:	Abn CR	Abn FFI	Abn CR	Abn FFI
NotLCD × Post	-0.41***	-1.34***	-0.20***	-0.51***
	(-4.96)	(-8.41)	(-3.07)	(-3.68)
NotLCD	0.56***	0.76***	0.35***	0.04
	(4.63)	(4.37)	(3.20)	(0.27)
Observations	21,482	21,482	20,548	20,548
R-squared	0.16	0.35	0.32	0.48

Table 10: Effects of LCD downgrades and upgrades through September 2019
Panel A of this table summarizes the results of the quarterly LCD updates that took place between May 2018 and September 2019 at a quarterly frequency, based on the portfolio holdings as at the end of each quarter. Panel B shows results of OLS regressions of monthly flows from May 2018 through September 2019 on *LCD Downgrade* and *LCD Upgrade*, and control variables (monthly return, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars). *LCD Downgrade* and *LCD Upgrade* are dummy variables equal to 1 for months following an LCD downgrade or upgrade, and 0 otherwise. All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered along month, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: LCD changes after April 2018

LCD updates	Aug 2018 (Q2-2018)	Nov 2018 (Q3-2018)	Feb 2019 (Q4-2018)	May 2019 (Q1-2019)	Aug 2019 (Q2-2019)
Downgrades	226 (1.14%)	192 (1.08%)	166 (0.84%)	274 (1.36%)	158 (0.78%)
Confirmations	19,462 (98.02%)	17,303 (97.59%)	19,218 (97.69%)	19,656 (97.28%)	19,872 (97.57%)
Upgrades	168 (0.85%)	235 (1.33%)	288 (1.46%)	276 (1.37%)	337 (1.65%)

Panel B: Effect of LCD changes after April 2018

	Full sample		Europe		USA	
Dep. variable:	(1) Flows	(2) Normalized flows	(3) Flows	(4) Normalized flows	(5) Flows	(6) Normalized flows
LCD Downgrade	-0.15***	-0.58*	-0.18***	-0.74**	0.02	0.31
	(-4.78)	(-2.11)	(-5.00)	(-2.60)	(0.31)	(0.66)
LCD Upgrade	0.25***	1.74***	0.24***	1.61***	0.23**	1.94***
	(5.45)	(6.23)	(4.44)	(4.36)	(2.50)	(3.99)
Observations	338,609	338,609	222,657	222,657	115,926	115,926
R-squared	0.09	0.10	0.11	0.10	0.06	0.17
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

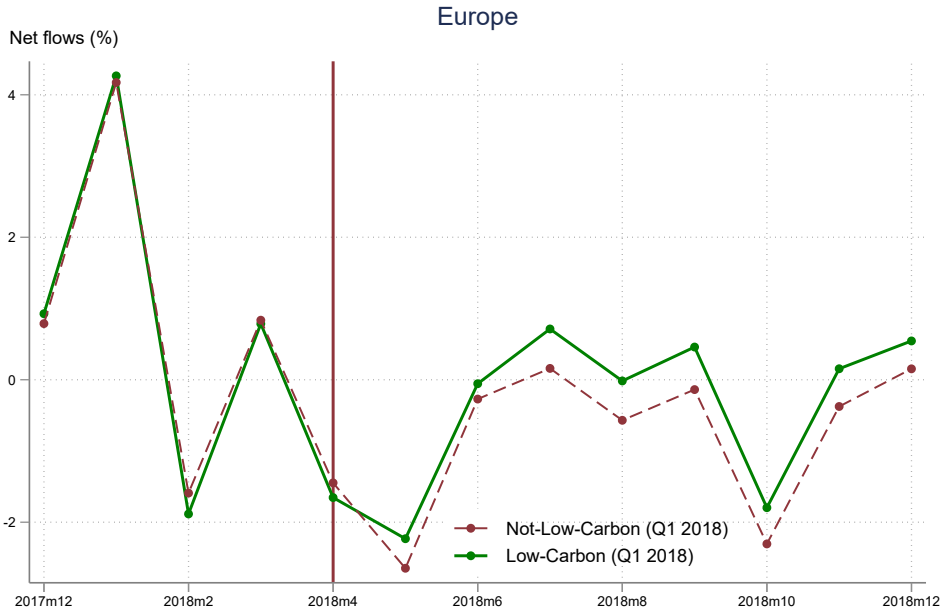
Table 11: LCD and idiosyncratic volatility

This table shows regressions of funds' idiosyncratic volatility on LCD, Morningstar Globes rating, and control variables. Idiosyncratic volatility is computed as the standard deviation of residuals from a Fama-French three-factor model run over the 17-month post-publication period from May 2018 through September 2019, for funds with at least 9 observations of monthly returns. Active is an indicator for mutual funds with Active Share $\geq$ 60%. Log assets is the average size of the fund across the post-publication period. t-statistics are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Dependent variable:	Idiosyncratic volatility			
	(1)	(2)	(3)	(4)
LCD	0.23***	0.06***	0.05***	0.07***
	(9.48)	(3.11)	(2.81)	(4.06)
Active			0.09***	0.10***
			(4.69)	(5.31)
Globes=1				0.28***
				(13.29)
Globes=2				0.06***
				(3.71)
Globes=4				-0.04**
				(-2.31)
Globes=5				-0.08***
				(-3.83)
Age	0.00***	-0.00	-0.00	-0.00
	(3.86)	(-0.55)	(-0.39)	(-0.05)
Log assets	-0.07***	-0.03***	-0.03***	-0.03***
	(-13.74)	(-8.90)	(-8.48)	(-7.57)
Manager tenure	0.01***	0.00**	0.00**	0.00
	(3.82)	(2.27)	(2.16)	(1.12)
Constant	2.80***	2.18***	2.08***	2.17***
	(31.56)	(37.57)	(33.75)	(32.17)
Observations	16,004	15,999	15,999	13,508
R-squared	0.15	0.66	0.66	0.66
Country FE	Yes	Yes	Yes	Yes
Category FE	No	Yes	Yes	Yes

Supplementary Appendix

Figure A1: Investors prefer low-carbon funds - Robustness check: Shorter pre-publication period with pre-publication labels
These figures show the equally-weighted average monthly flows from December 2017 through December 2018 of European (top) and US (bottom) funds that had portfolios with low-carbon features (solid green lines) and of those that did not (dashed red line). These graphs leverage on the availability of LCD data from December 2017 to April 2018 (pre-publication period). Flows are computed as of end of the month.



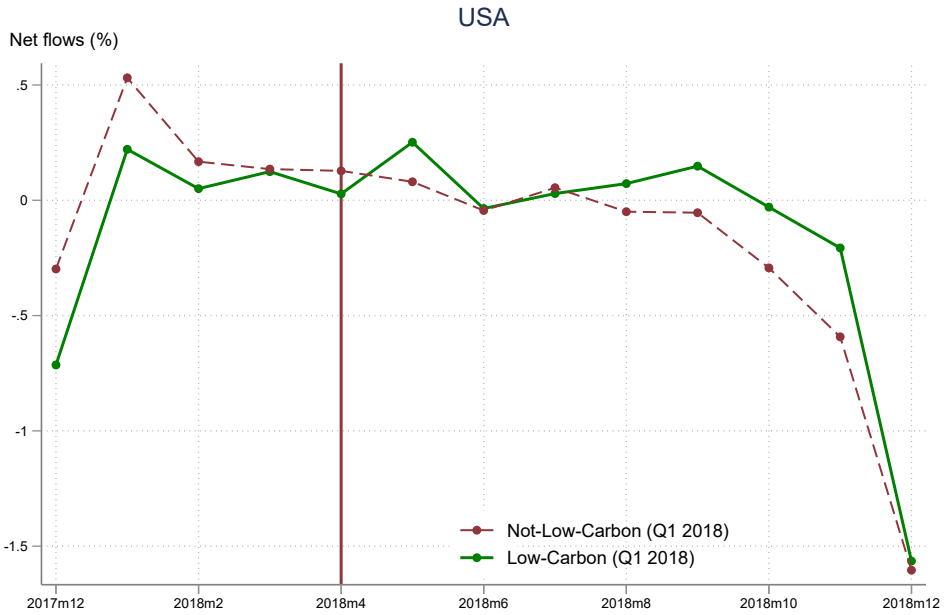


Table A1: : Firm-level Carbon Risk scores by GICS sectors

This table shows the descriptive statistics of 2017 firm-level Carbon Risk scores from the ESG research provider Sustainalytics, by GICS sector. Panel A looks at firms head-quartered in Europe, while Panel B looks at firms head-quartered in the USA. According to Sustainalytics, the Carbon Risk score capture the remaining unmanaged carbon risk after taking into account a firm's carbon risk management activities (for details, see Morningstar, 2018b). Morningstar uses the firm-level Carbon Risk scores from Sustainalytics to compute the value-weighted fund-level Carbon Risk scores.

Panel A: Europe

	N	min	p25	mean	p50	p75	max	sd
Energy	34	8.89	16.90	28.31	26.46	35.97	62.89	14.14
Materials	74	1.59	11.63	18.33	17.33	24.54	48.40	8.02
Industrials	170	0.00	6.51	13.92	13.70	21.90	36.05	9.26
Consumer discretionary	108	0.00	0.00	8.51	7.23	12.13	41.25	7.93
Consumer staples	51	0.00	3.89	8.42	6.97	12.01	20.69	5.62
Health Care	65	0.00	0.00	2.72	0.00	5.93	14.72	4.49
Financials	144	0.00	7.95	11.70	11.86	15.27	25.20	5.27
IT	62	0.00	0.00	3.21	0.00	5.92	23.91	5.14
Communication	62	0.00	0.00	5.39	3.49	9.40	19.36	6.22
Utilities	41	0.00	8.50	15.80	14.00	23.54	38.70	9.64
Real Estate	67	4.28	8.44	12.68	12.54	17.13	20.70	4.92
Total	878	0.00	4.61	11.30	10.32	15.96	62.89	9.34

Panel B: USA

	N	min	p25	mean	p50	p75	max	sd
Energy	106	0.00	12.27	33.61	24.07	58.15	75.28	24.24
Materials	104	0.00	9.93	16.40	15.35	21.64	63.51	11.59
Industrials	149	0.00	8.27	14.84	14.21	21.16	46.22	9.56
Consumer discretionary	131	0.00	0.00	11.58	10.10	17.63	67.65	11.22
Consumer staples	60	0.00	4.74	12.03	10.64	17.50	58.06	10.08
Health care	95	0.00	0.00	8.97	7.28	14.37	81.09	11.08
Financials	161	0.00	7.24	13.03	12.98	16.25	76.20	10.19
IT	125	0.00	0.00	9.95	7.81	14.41	67.32	12.06
Communication	58	0.00	0.00	8.95	7.62	14.78	35.07	8.69
Utilities	52	0.00	9.67	16.27	16.48	23.14	37.79	10.26
Real Estate	104	0.00	8.73	13.92	13.80	18.72	54.08	8.76
Total	1,145	0.00	5.78	14.61	12.55	19.50	81.09	13.98

Table A2: Correlations between variables

This table shows the correlations between variables for the period from April 2017 through September 2019. * indicates that the parameter estimate is significantly different from zero at the 1% level.

Variables	1	2	3	4	5	6	7	8	9	10
1. LCD										
2. Flows	0.01*									
3. Normalized flows	0.02*	0.75*								
4. Return	0.04*	0.06*	-0.03*							
5. Log assets	0.08*	-0.01*	-0.01*	0.03*						
6. Volatility	0.19*	-0.05*	-0.02*	0.04*	-0.00					
7. Age	0.07*	-0.11*	-0.14*	0.01*	0.29*	0.05*				
8. Globes	0.09*	-0.00	0.00	0.01*	-0.02*	-0.08*	0.03*			
9. Stars	0.06*	0.14*	0.17*	0.04*	0.31*	-0.06*	0.00	-0.02*		
10. Socially conscious	0.11*	0.03*	0.04*	0.01*	0.05*	0.03*	-0.03*	0.17*	0.04*	
11. Institutional	-0.03*	0.03*	0.06*	0.00	0.15*	-0.02*	-0.12*	-0.04*	0.12*	0.05*

Table A3: Investors prefer low-carbon funds - Robustness check: Adding fund fixed effects

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), the interaction of this variable with a dummy Post equal to 1 for months following April 2018 (publication period), and control variables. Models (1), (3) and (5) use monthly net flows as the dependent variable, while models (2), (4), and (6) use monthly normalized flows. All regressions control for month-by-style and fund fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered along month, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
Dep. variable:	(1) Flows	(2) Normalized flows	(3) Flows	(4) Normalized flows	(5) Flows	(6) Normalized flows
LCD × Post	0.40***	2.65***	0.45***	2.97***	0.35***	2.20***
	(6.42)	(4.26)	(6.20)	(4.12)	(4.67)	(4.33)
Observations	396,398	396,398	255,579	255,579	140,767	140,767
R-squared	0.34	0.36	0.36	0.32	0.35	0.50
Constant & controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

Table A4: Investors prefer low-carbon funds - Robustness check: Fully interacted model

This table shows results of difference-in-differences regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), control variables (monthly return, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars), and the interaction of all variables with a dummy Post equal to 1 for months after April 2018. t-statistics, based on robust standard errors clustered at month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.23***	2.17***	0.28***	2.58***	0.16*	1.62**
	(3.45)	(3.34)	(4.21)	(3.56)	(1.85)	(2.50)
LCD	0.14***	1.11***	0.07*	0.69**	0.26***	1.86***
	(4.13)	(3.68)	(1.85)	(2.17)	(6.17)	(6.58)
Return × Post	-0.09	-0.53	-0.07	-0.12	0.01	0.04
	(-1.43)	(-0.72)	(-1.22)	(-0.19)	(0.10)	(0.09)
Log assets × Post	0.03	-0.71*	-0.03	-1.10*	0.02	-1.09
	(1.13)	(-1.89)	(-1.61)	(-1.87)	(0.90)	(-1.72)
Volatility × Post	0.09	0.79	0.15*	1.25*	0.03	0.39
	(0.99)	(0.96)	(1.94)	(1.79)	(0.27)	(0.51)
Age × Post	0.06**	0.02***	0.03	0.01**	0.06	
	(5.57)	(2.09)	(4.98)	(0.69)	(2.81)	(1.41)
Δ1 Globe × Post	-0.03	-0.63	0.10	0.11	-0.15	-0.45
	(-0.26)	(-1.05)	(0.70)	(0.16)	(-0.95)	(-0.38)
Δ5 Globes × Post	0.16	1.48	0.08	1.23	0.13	0.09
	(1.24)	(1.52)	(0.74)	(1.41)	(0.86)	(0.08)
ΔStars × Post	0.03	0.27	0.04	0.26	0.03	0.33
	(0.49)	(0.55)	(0.52)	(0.46)	(0.57)	(0.81)
Observations	396,398	396,398	255,579	255,579	140,767	140,767
R-squared	0.14	0.12	0.19	0.12	0.07	0.21
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE month	Yes	Yes	Yes	Yes	Yes	Yes

Table A5: Investors prefer low-carbon funds - Robustness check: Controlling for CR and FFI

This table shows results of OLS difference-in-differences (DID) regressions of monthly flows from April 2017 through December 2018 on Low Carbon Designation (LCD), Portfolio Carbon Risk (CR) and Fossil fuel involvement (FFI), their interaction with Post, and control variables (monthly return, volatility, log asset, age, Δ1 Globe, Δ5 Globes, ΔStars). All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors clustered at month level, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Flows	Normalized flows	Flows	Normalized flows	Flows	Normalized flows
LCD × Post	0.28***	2.27***	0.31***	2.32***	0.13	1.54***
	(4.17)	(3.99)	(4.07)	(3.32)	(1.26)	(3.08)
LCD	-0.03	-0.41	-0.04	-0.16	0.02	-0.82**
	(-0.65)	(-1.19)	(-0.79)	(-0.40)	(0.45)	(-2.19)
CR	-0.02*	-0.19**	0.01	-0.01	-0.05***	-0.44***
	(-1.93)	(-2.68)	(0.70)	(-0.08)	(-6.57)	(-6.84)
CR × Post	-0.01	-0.05	-0.01	-0.10	-0.04	-0.29*
	(-0.34)	(-0.37)	(-0.79)	(-0.89)	(-1.44)	(-1.89)
FFI	-0.03***	-0.22***	-0.04***	-0.25***	-0.01***	-0.16***
	(-6.68)	(-8.18)	(-7.04)	(-7.69)	(-3.14)	(-5.66)
FFI × Post	0.02***	0.14***	0.02***	0.13**	0.03***	0.23***
	(3.28)	(3.11)	(3.10)	(2.60)	(3.03)	(4.44)
Observations	220,101	220,101	154,773	154,773	65,236	65,236
R-squared	0.14	0.12	0.18	0.12	0.10	0.26
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Two-way clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A6: Financial and climate performance

This table shows results of OLS regressions of monthly returns from May through September 2019 on the Low Carbon Designation (LCD) and control variables (log assets, volatility, and age). The dependent variable is CAPM-adjusted returns in models 1, 3 and 5, and Fama-French-adjusted returns in models 2, 4, and 6. Both sets of returns are based on betas estimated with monthly returns from January 2016 through December 2017. All regressions control for month-by-style and country fixed effects. t-statistics, based on robust standard errors double-clustered along month and fund, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

	Full sample		Europe		USA	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	CAPM-adj. returns	FF-adj. returns	CAPM-adj. returns	FF-adj. returns	CAPM-adj. returns	FF-adj. returns
LCD	0.36**	0.21**	0.36**	0.22**	0.40**	0.20*
	(2.46)	(2.81)	(2.40)	(2.86)	(2.33)	(2.03)
Log assets	0.01***	0.01**	0.03***	0.03***	0.00	-0.01
	(2.93)	(2.19)	(3.48)	(3.11)	(0.11)	(-0.73)
Volatility	-0.02	0.04	-0.00	0.06	-0.10	-0.09
	(-0.20)	(0.53)	(-0.06)	(0.73)	(-1.47)	(-1.46)
Age	-0.00	0.00	-0.00	0.00	0.00	0.00
	(-0.37)	(1.54)	(-1.71)	(1.57)	(0.16)	(0.24)
Observations	287,988	287,988	183,024	183,024	104,919	104,919
Adjusted R-squared	0.47	0.44	0.63	0.60	0.48	0.47
Month-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Two-way clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Table A7: Funds tilt portfolios towards low-carbon firms - Robustness checks
This table shows additional robustness tests for the analyses of mutual funds' responses to the introduction of the LCD. These are results of OLS difference-in-differences (DID) regressions of quarterly Abnormal Carbon Risk (Abn CR) and Abnormal Fossil Fuel Involvement (Abn FFI) from March 2017 through September 2019 on the interaction between the dummy NotLCD (funds that did not receive the LCD at the initial release) and the dummy Post (period after April 2018). Abnormal climate performance metrics are constructed to account for price changes by subtracting for each category-month pair the mean CR and FFI of explicit indexers and passive investors (Active Share $\leq$60%). We compute the means separately by the degree to which the treatment criteria are fulfilled, i.e., $\varnothing$CR$\leq$10 only, $\varnothing$FFI$\leq$7 only, both, and none. Panel A adds fund FEs to the main specification. Panel B runs a fully interacted model. The sample in Panels A and B includes all active mutual funds domiciled in Europe or USA. All regressions control for quarter-by-style fixed effects and lagged fund-level controls. The direct effect of the dummy Post is absorbed by the time fixed effects. Singleton observations are dropped. t-statistics, based on robust standard errors clustered along fund, are reported in parentheses. ***, **, and * indicate that the parameter estimate is significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Fund fixed effects

	Full sample		Europe		US	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Abn CR	Abn FFI	Abn CR	Abn FFI	Abn CR	Abn FFI
NotLCD × Post	-0.14***	-0.60***	-0.17***	-0.72***	-0.08	-0.32***
	(-4.87)	(-9.14)	(-4.84)	(-9.17)	(-1.61)	(-2.60)
Observations	85,969	85,969	57,769	57,769	28,189	28,189
R-squared	0.89	0.88	0.89	0.89	0.90	0.87
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes

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Panel B: Fully interacted model

	Full sample		Europe		US	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable:	Abn CR	Abn FFI	Abn CR	Abn FFI	Abn CR	Abn FFI
NotLCD × Post	-0.38***	-0.94***	-0.36***	-1.00***	-0.42***	-0.72***
	(-10.32)	(-12.60)	(-8.51)	(-11.56)	(-5.47)	(-5.00)
NotLCD	0.49***	0.45***	0.30***	0.09	0.90***	1.29***
	(8.91)	(5.78)	(4.95)	(0.93)	(7.48)	(9.18)
Quarterly return × Post	-0.13***	-0.12***	-0.12***	-0.09***	-0.20***	-0.21***
	(-17.36)	(-7.82)	(-15.07)	(-6.07)	(-10.09)	(-5.27)
Log assets × Post	-0.02	-0.02	-0.02	0.01	-0.02	-0.06
	(-1.59)	(-0.83)	(-1.19)	(0.21)	(-1.10)	(-1.56)
Volatility × Post	0.19***	-0.09	0.18***	-0.11	0.07	-0.17
	(3.60)	(-0.81)	(3.25)	(-0.96)	(0.60)	(-0.88)
Age × Post	0.01***	0.03***	0.01*	0.03***	0.01**	0.03**
	(3.14)	(4.55)	(1.67)	(3.96)	(2.55)	(2.51)
Observations	86,063	86,063	57,846	57,846	28,206	28,206
R-squared	0.19	0.37	0.24	0.39	0.23	0.39
Constant & controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-Style FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE fund	Yes	Yes	Yes	Yes	Yes	Yes

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